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Spherical cap-shaped emulsion films: thickness evaluation at the nanoscale level by the optical evanescent wave effect

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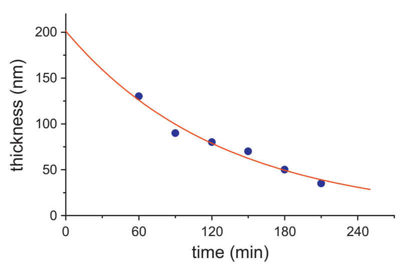
HIGHLIGHTS

- Principles of evanescent wave optics are reviewed.
- Simulated measurements of thin film thickness are illustrated.
- Example application to acquired images of real emulsion films demonstrates the reliability of the presented methodology for observing the thinning behavior of the film with a sub-wavelength spatial resolution.

GRAPHICAL ABSTRACT

Time evolution of the thickness for an emulsion film, constituted by SDS-aqueous solution (concentration $c = 0.02$ mol/dm^3) in hydrocarbon matrix (n-decane). Blue dots: evaluated thickness from observed optical images; red line: exponential fitting curve.



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ABSTRACT

A new methodology, based on fundamental optical principles relevant to the evanescent wave properties, is developed to evaluate the thinning behavior and the local thickness in different positions for curved aqueous emulsion films, generated in a hydrocarbon matrix. This methodology is applied to test data obtained by a specially-designed bread-board cell. The generated films, constituted by an aqueous sodium dodecylsulfate solution at concentration $c = 2.5$ times the critical micellar concentration, remain stable during several hours. The results show a slow evolution of the film thickness as a function of time starting from micrometric dimension, at the initial film formation, to a few nanometres prior to film breakage. The action of the gravitational drainage is furthermore assessed by the local thickness values in different positions of the film profile. The illustrated examples demonstrate that the evanescent wave effect can be advantageously adopted as a complementary measurement technique, additional to the usual interferometric technique.

1. Introduction

Liquid interfaces, subjected to dynamic conditions, exhibit a constitutive interfacial viscoelasticity and an inherent specific phenomenology, caused by adsorption film-forming substances [1]. As known, the rheological and the hydrodynamic properties of

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